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# BEAM AND COLUMN DATA

COMPLIMENTS OF  
**NORTHWESTERN EXPANDED METAL CO.**

930-950 OLD COLONY BUILDING

**CHICAGO**

TELEPHONE—HARRISON 789

Factory  
CHICAGO, ILL.

Factory  
CANTON, OHIO

MANUFACTURERS OF



AND

**"KNO-BURN" EXPANDED  
METAL PLASTERING LATH**

WHEN EXPANDED METAL REINFORCEMENT IS USED  
IN SLABS *ALL THE AREA OF THE STEEL IN*  
CROSS SECTION IS *AVAILABLE FOR REIN-*  
*FORCEMENT.* NO ADDITIONAL STEEL IS RE-  
QUIRED FOR BINDING OR CROSS BEARING PURPOSES

IDEAL REINFORCEMENT FOR CONCENTRATED LOADS  
AND TO CARE FOR INDETERMINATE STRESSES

CANNOT SLIP. NO LOOSE JOINTS. NO WEAVING.  
NO WELDING. SHEARED FROM SOLID PLATES.

**The Northwestern  
Expanded Metal Co.**

**DESIGNING BOOKLETS**

**Sent "Free on Request"**

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- No. 1. **THE USE OF EXPANDED METAL.**—A reprint of an article in the October, 1908 issue of *Concrete*, by Ernest McCullough. (Out of print.)
- No. 2. **CONCRETE AND STEEL.**—Contains valuable hints to architects on the preparation of specifications for reinforced concrete construction. (Out of print.)
- (Subject-matter in booklets out of print is scattered through other booklets in the series.)
- No. 3. **KNO-BURN METAL PLASTERING LATH.**—An up-to-date manual for plasterers containing recipes for mortar mixtures and coloring of mortar. Also describes Kno-Burn Metal Plastering Lath with instructions for use of same and specifications.
- No. 4. **ROOF AND FLOOR SLAB.**—Contains 13 tables giving strength and carrying capacity of slabs varying in thickness from  $1\frac{1}{4}$  inches to 12 inches and with spans from 3 to 20 feet, reinforced with expanded metal. Contains also other valuable tables for designers.
- No. 5. **BEAMS AND COLUMNS.**—Supplementary to No. 4 and comprising with it the most complete manual on reinforced concrete design that has been issued by any manufacturer of reinforcement.

## IMPORTANT.

MARCH 31ST, 1909.

We have this date discarded the old method of designating expanded metal by mesh, gauge and width of strand. It lacked flexibility and being confusing led to many mistakes.

Hereafter, prominence will be given to areas and weights thus making expanded metal directly comparable with other forms of reinforcing material.

The change is made for the convenience of customers and we hope that the use of words such as "regular" and "standard" will be discontinued.

Orders however will be promptly filled no matter how the material is described, provided the customer makes his meaning clear.

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## HOW TO ORDER EXPANDED METAL.

A CAREFUL READING OF THESE INSTRUCTIONS MAY  
SAVE TIME AND MONEY.

There are no fixed, universal standards for Expanded Metal as for rods and bars.

For the convenience of those wanting to specify our material we have numbers. As other companies have numbers do not forget to give name of company with the number or we will assume our number is wanted.

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Customers desiring to procure expanded metal similar to some they have, should order by giving size of mesh and weight per square foot of the material they want duplicated.

Weigh a sheet and give us the total weight and the exact area so it can be figured out in our office. It is best in all cases to send a sample of the material.



SYSTEM No. 11



SYSTEM No. 13 D.



SYSTEM No. 15



SYSTEM No. 23 C.

trated on page 10, System 37. As steel is cheaper than concrete this last method of reinforcement often pays. It saves the slight trouble of raising the metal at supports. When used in storage warehouse the lower reinforcement often goes straight through and the top reinforcement is additional. This takes care of excessive shear as well as of reverse bending moments.

While the exact amount of reinforcement over supports may be figured and used for slabs and they may be figured as continuous or partially continuous it is not good practice to figure beams and girders except as freely supported with  $M = \frac{wl^2}{8}$ . Negative bending moments, however, exist at the supports so that steel should be supplied at the tops of beams and girders over supports to take care of  $M = \frac{wl^2}{12}$ .

The deflection of reinforced concrete beams is only about one-third the deflection of steel I beams of equal strength. A floor slab over a number of reinforced concrete beams can be figured as continuous. It can be figured as continuous if placed over a number of I beams encased in concrete poured when the floor slab is poured. If the I beams however are not encased in concrete then the slab should be figured as only partially continuous because of the greater deflection of the steel beams.

#### DESIGNING LOADS.

See page 16, Roof and Floor Slab booklet for weights of roof and floor materials.

See page 17, Roof and Floor Slab booklet for live loads generally allowed in Building Ordinances.

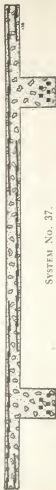
The dead load of a structure is the weight of the girders, beams, slabs and roof or floor covering. The live load is a load not constantly applied, although it may be stationary for long periods of time. Superimposed safe load, is a better term than live load and means a load in addition to the dead load. Moments are calculated from total load which is the sum of the dead load and the superimposed safe load.

The factor of safety does not apply to the live load but to the amount of stress in the materials.



PLASTER CEILING

SYSTEM No. 24 B.



SYSTEM No. 37.



METHOD G.



METHOD H.

A floor designed to carry four times the live load has not a factor of safety of four. If it can carry four times the total load it then has such a factor.

Some designers take half the dead load and once the live load and use a fiber stress in the materials. Actually however the fiber stress under the live load is greater than the specifications call for so the practice is neither honest nor sensible. Too large a proportion of the strength of the materials is exerted in carrying the dead load. This also increases the cost of columns and footings. The owners of reinforced concrete buildings do not understand these things fully enough or there would be less call for long span construction. A number of instances have been reported where the absence of girders and beams produced buildings in which resonance is a decided nuisance and false beams and girders have been put in hallways to break up echoes. This is when the floors are solid. When a ceiling is suspended beneath the floor, to hide the beams so many people object to, there is no resonance.

The best way to design floor and roof systems is to use short spans, thus increasing the strength and stiffness of the structure, reducing weight, which goes to the foundations and makes necessary heavier columns and beams, and lessening cost. If the intermediate beams are considered objectionable suspended ceilings can be used to conceal them. Therefore, assume as a total load one and one-half times the live load and equate for span. Let  $W$  = total load on span.

$$l = \text{span.}$$

$$M = \text{bending or resisting moment} = Rbd^2.$$

$$\text{then } l = \sqrt{\frac{8M}{W}} \text{ for freely supported spans.}$$

$$l = \sqrt{\frac{10M}{W}} \text{ for partially continuous spans.}$$

$$l = \sqrt{\frac{12M}{W}} \text{ for continuous spans.}$$

By using actual loads and taking fiber stresses in the materials the factor of safety desired is obtained. Reinforced concrete formulas wherein fiber stresses are used in connection with safe loads are known as Straight Line Formulas. In this

series of booklets only such formulas are used and the factor of safety is 4. Formulas using the ultimate strength of the materials and breaking loads, are known as parabolic formulas. Straight line formulas give sizes possessing greater rigidity than parabolic formulas and as a rule are the only formulas permitted to be used in cities possessing building regulations governing reinforced concrete.

The span length used should be the clear span plus depth of slab, beam or girder except when this would exceed the distance center to center of supports in which case the latter is the span length. Brackets should not be used to reduce the span length used.

Full dead and live load should be used for slabs and beams. For girders the assumed live load can be reduced 15 per cent. except in buildings used for storage purposes.

In designing columns the full dead load for each floor is carried to the column. As it seldom happens that all floors are loaded at one time to the full amount assumed, the live load is reduced 5% for the first floor below the roof when assuming loads to go to columns; 10% for the second floor below the roof, 15% for the third, etc., until a floor is reached where the reduction amounts to 50% of the live load, after which 50% of the live load is used for the remaining floors.

For slabs supported on the four sides  $M = \frac{wl^2}{20}$  when the panel is exactly square. There will be an equal amount of reinforcement in two directions crossing at right angles. This reinforcement will of course be in two layers and the slab thickness found by calculation must be increased by the thickness of the extra layer of steel.

When the length of the panel is greater than the width and is equal to or less than, 1.5 times the width, the reinforcement must run in both directions, the proportions of load going to the supports on the side being found by the following formula:

Let  $r$  = proportion of load carried by the sides

$L$  = length of panel

$b$  = breadth of panel

$$\text{then } r = \frac{L^2}{L^2 + 8b^2}$$

Having found the proportions of load to be carried each way the bending moment is found as for a continuous slab, there being of course the proper amount of steel placed in the top over supports to care for negative bending moments.

When the length of the panel exceeds 1.5 times the breadth the portion of load carried by the cross beams is within the area found by drawing lines at an angle of  $45^\circ$  from each corner to an intersection.

All the foregoing calculations can be dispensed with by using expanded metal and reinforcing for load across short span. The mesh being diamond shaped the strands run in the right directions to care for all strains developed in the slabs. See pages 1 and 2, Roof and Floor Slab booklet.

#### HOW TO FIGURE BEAM SIZES.

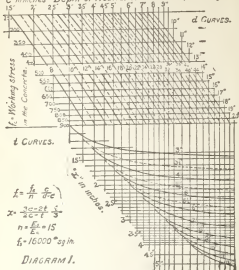
The formulas given on pages 4 and 7 are all that are necessary to determine the sizes of beams and girders. The width of a beam should be not less than  $1/24$  the span. The best proportioned beam is that in which  $b = \frac{1}{2}h$  to  $\frac{2}{3}h$ . Assuming that the beam and slab it carries will be poured at one operation the top of the beam may be taken as the top of the slab. If not poured at one operation the top of the beam will be at the bottom of the slab thus increasing total depth.

Beams may often be figured as of T section and some concrete saved. Diagram 2 contains a cut of such a beam. Properly proportioned "b" should not exceed  $\frac{1}{4}$  the span length of the beam, or it should not exceed  $6t + b'$ .

The formulas already mentioned may be used to compute such beams and the steel proportioned accordingly. The steel is a percentage of the rectangle  $bd$ . The stem  $b'$  however needs only to be wide enough to contain the steel and its enveloping concrete. In computing shear  $b'$  is used and not  $b$ . The slab thickness should be not less than  $1/5d$ .

Diagrams 1 and 2 are for the design of T beams. Entering the upper half of Diagram 1 at the concrete fiber stress, intersect with the  $d$  curve and follow the  $c$  line down to the slab thickness. On the left is found  $x$ .

$c$  = inches = Depth of Neutral Axis below top of Flange.

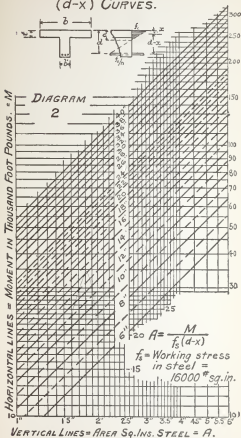


Subtract  $x$  from  $d$ . Find bending moment in foot pounds. Enter Diagram 2 on line representing this bending moment. Follow to an intersection with the  $d-x$ , just found. Drop vertically to the steel area in square inches.

The slab thickness is found in the Roof and Floor Slab booklet, preferably. The depth is generally governed by the head room wanted. That the conditions for a properly designed beam may be fulfilled  $b \geq \frac{M}{R d}$  and if these conditions are not fulfilled at the first trial, try again.

#### HOW TO FIGURE EXPANDED METAL REINFORCEMENT.

The loading being assumed and the spans determined, bending moments are calculated as shown on pages 5 and 7. The formulas on pages 4 or 7 are then used to obtain the depth of the slab and the area of reinforcement.

*(d-x) CURVES.*

(Diagrams for Reinforced Concrete Design, by G. F. Dodge, is a new book containing complete diagrams for solving all problems.)

TABLE VIIa

Specification for the Reinforcement — Three inch mesh, Northwestern Expanded Metal, weighing 0.82 lb. per sq. ft. Laid to give an area of 0.263 sq. ins. per 12" width.

| SPAN                            |                                 | 3'6"  | 4'  | 4'6" | 5'  | 5'6" | 6'  | 7'  | 8'  | 9'  | 10' | 11' | 12' |
|---------------------------------|---------------------------------|---|-----|------|-----|------|-----|-----|-----|-----|-----|-----|-----|
| Depth of<br>footings<br>in feet | Depth of<br>footings<br>in feet | SUPERIMPOSED SAFE LOADS IN POUNDS PER SQUARE FOOT |     |      |     |      |     |     |     |     |     |     |     |
|                                 |                                 | 1-2-4 Broken Stone or Washed Gravel Concrete      |     |      |     |      |     |     |     |     |     |     |     |
| 2'                              | 24                              | 129   | 93  | 68   | 51  | 37   | 28  | 14  | 5   |     |     |     |     |
| 2½'                             | 3                               | 220   | 174 | 130  | 100 | 77   | 60  | 35  | 20  | 9   |     |     |     |
| 3'                              | 37                              | 370   | 277 | 212  | 170 | 124  | 100 | 88  | 41  | 25  | 13  |     |     |
| 3½'                             | 43                              | 520   | 385 | 295  | 210 | 185  | 150 | 95  | 65  | 40  | 25  | 14  |     |
| 4'                              | 49                              | 610   | 455 | 350  | 270 | 215  | 165 | 110 | 75  | 50  | 30  | 17  | 7   |
| 4½'                             | 55                              | 705   | 525 | 405  | 300 | 255  | 195 | 135 | 90  | 60  | 38  | 22  | 10  |
| 5'                              | 61                              | 810   | 605 | 465  | 365 | 290  | 235 | 155 | 105 | 70  | 45  | 27  | 13  |
|                                 |                                 | 1-2-5 Broken Stone or 1-5 Bank Gravel Concrete    |     |      |     |      |     |     |     |     |     |     |     |
| 6'                              | 73                              |   | 815 | 580  | 455 | 365  | 295 | 195 | 135 | 95  | 60  | 35  | 20  |
| 7'                              | 85                              |   | 915 | 685  | 550 | 440  | 355 | 240 | 160 | 110 | 75  | 47  | 25  |
| 8'                              | 98                              |   |     | 820  | 645 | 520  | 420 | 280 | 190 | 130 | 88  | 55  | 30  |
| 9'                              | 110                             |   |     | 895  | 740 | 590  | 480 | 325 | 220 | 150 | 100 | 65  | 37  |
| 10'                             | 122                             |   |     | 945  | 830 | 665  | 540 | 365 | 250 | 170 | 115 | 75  | 44  |

TABLE VIIIa

Specification for the Reinforcement — Three inch mesh, Northwestern Expanded Metal, weighing 1.36 lb. per sq. ft. Laid to give an area of 0.437 sq. ins. per 12" width.

| SPAN                | 6'  | 7'  | 8'  | 9'  | 10' | 11' | 12' | 13' | 14' | 15' | 16' | 17' |    |
|---------------------|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| 3<br>inches<br>mesh | SUPERIMPOSED SAFE LOADS IN POUNDS PER SQUARE FOOT |     |     |     |     |     |     |     |     |     |     |     |    |
|                     | 1-2-4 Broken Stone or Washed Gravel Concrete      |     |     |     |     |     |     |     |     |     |     |     |    |
| 6'                  | 74  | 37  | 19  | 7   |     |     |     |     |     |     |     |     |    |
| 7'                  | 3   | 78  | 49  | 30  | 17  | 8   | 2   |     |     |     |     |     |    |
| 8'                  | 37  | 124 | 78  | 54  | 35  | 21  | 11  | 3   |     |     |     |     |    |
| 9'                  | 43  | 187 | 110 | 87  | 60  | 40  | 26  | 15  | 6   |     |     |     |    |
| 4'                  | 48  | 155 | 174 | 127 | 86  | 60  | 41  | 27  | 15  | 7   |     |     |    |
| 4½'                 | 53  | 133 | 230 | 16  | 118 | 85  | 60  | 42  | 28  | 17  | 7   |     |    |
| 5'                  | 6   | 4   | 108 | 92  | 71  | 51  | 10  | 81  | 58  | 40  | 26  | 15  | 6  |
| 6'                  | 73  | 183 | 276 | 18  | 134 | 103 | 75  | 53  | 35  | 21  | 10  |     |    |
| 7'                  | 85  | 208 | 439 | 110 | 232 | 172 | 127 | 93  | 67  | 46  | 29  | 15  |    |
| 8'                  |   | 345 | 133 | 102 | 147 | 115 | 110 | 79  | 55  | 35  | 19  | 6   |    |
|                     | 1-2-5 Broken Stone or 1-5 Bank Gravel Concrete    |     |     |     |     |     |     |     |     |     |     |     |    |
| 10'                 | 122   | 439 | 147 | 131 | 231 | 173 | 128 | 93  | 65  | 42  | 24  | 8   |    |
| 11'                 | 125   | 505 | 167 | 142 | 255 | 264 | 188 | 147 | 106 | 75  | 49  | 29  | 11 |

Table XVI gives data by which to select a weight of slab to carry certain live loads. Along the top are placed the live loads. In the left hand column is the weight per square foot of the slab and in the columns under the live loads are the spans. Enter the table on the top at the assumed live load. Drop down to the assumed span, or one nearest to it. On the right will be the weight of slab to carry that load on that span. This is of course for the first trial as each slab requires a trial and final calculation. If the proportion is too great then it is best to assume 1.5 times the live load for the total load and equate for span.

At this point look in the tables of stock sizes for the area coming nearest to the one found. To obtain the full effect of expanded metal the edges of the sheets should lap at least one mesh so the whole reinforcement will act as one sheet. This lap is counted in as part of the reinforcement.

All slab calculations can be avoided by using the tables in the Roof and Floor Slab booklet and the additional tables VIIa and VIIIa in this booklet.

TABLE XVI

Approximate weight per square foot of concrete slabs for indicated live loads and spans.

| Weight in<br>lbs. Sq. Ft. | LIVE LOADS IN POUNDS PER SQUARE FOOT. |    |    |     |     |     |     |     |     |     |     |     |     |
|---------------------------|---------------------------------------|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                           | 25                                    | 50 | 75 | 100 | 125 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 |
|                           | SPANS IN FEET $M = \frac{wl^2}{8}$    |    |    |     |     |     |     |     |     |     |     |     |     |
| 25                        | 5                                     | 4  | 4  | 3   |     |     |     |     |     |     |     |     |     |
| 35                        | 8                                     | 7  | 6  | 5   | 5   | 5   | 4   | 4   | 3   | 3   |     |     |     |
| 45                        | 9                                     | 8  | 7  | 6   | 6   | 6   | 5   | 4   | 4   | 4   | 4   | 3   | 3   |
| 50                        | 10                                    | 9  | 8  | 7   | 7   | 6   | 6   | 5   | 5   | 5   | 4   | 4   | 4   |
| 55                        | 11                                    | 10 | 9  | 8   | 8   | 7   | 7   | 6   | 6   | 5   | 5   | 5   | 4   |
| 60                        | 13                                    | 11 | 10 | 9   | 9   | 8   | 7   | 7   | 6   | 6   | 6   | 5   | 5   |
| 70                        | 14                                    | 12 | 11 | 10  | 9   | 9   | 8   | 7   | 7   | 6   | 6   | 6   | 6   |
| 75                        | 15                                    | 13 | 12 | 11  | 10  | 10  | 9   | 8   | 8   | 7   | 7   | 6   | 6   |
| 85                        | 16                                    | 15 | 14 | 13  | 12  | 11  | 10  | 9   | 9   | 8   | 8   | 7   | 7   |
| 100                       | 18                                    | 16 | 15 | 14  | 13  | 13  | 12  | 11  | 10  | 9   | 9   | 9   | 8   |
| 110                       | 20                                    | 18 | 17 | 16  | 15  | 14  | 13  | 12  | 11  | 11  | 10  | 10  | 9   |
| 125                       | 21                                    | 19 | 18 | 17  | 16  | 15  | 14  | 13  | 12  | 12  | 11  | 11  | 10  |
| 140                       | 22                                    | 21 | 20 | 18  | 18  | 17  | 15  | 14  | 14  | 13  | 12  | 12  | 11  |
| 150                       | 24                                    | 22 | 21 | 20  | 19  | 18  | 17  | 16  | 15  | 14  | 13  | 13  | 12  |

Table XVIII shows the reinforcing value per 12" width of various weights of expanded metal in 3" mesh, for different side laps. For example an area of 0.336 sq. ins. per 12" width is wanted. The table shows that a sheet of 3" mesh, #19 6 ft. wide lapped one mesh on the side will give the required area. If the area wanted had been 0.351 sq. ins. it would required a sheet three feet wide lapped one mesh on the side.

If expanded metal is found to lack area, even when lapped, the deficiency can be supplied by wiring bars to the sheets at intervals or by placing down the middle of each sheet a strip of expanded metal one, two, three or four meshes wide of some heavier strand. This is best, for the meshes nest very nicely so the moment arm is not increased whereas the extra thickness of the bar must be taken into account.

TABLE XVII

Areas in square inches of strips of Northwestern Expanded Metal for additional reinforcement as a substitute for bars or rods.

| NUMBER | WIDTHS OF STRIPS. |          |          |          |
|--------|-------------------|----------|----------|----------|
|        | 1 MESH            | 2 MESHES | 3 MESHES | 4 MESHES |
| 7      | .016              | .033     | .049     | .065     |
| 9      | .024              | .049     | .073     | .097     |
| 11     | .015              | .030     | .044     | .059     |
| 13     | .027              | .055     | .082     | .109     |
| 15     | .041              | .081     | .122     | .162     |
| 17     | .061              | .122     | .183     | .243     |
| 19     | .081              | .162     | .243     | .324     |
| 21     | .10               | .20      | .30      | .40      |

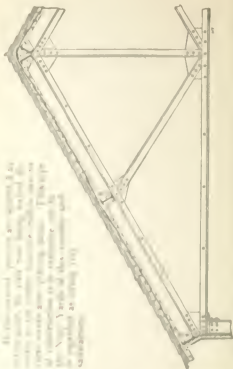
## AREAS AND WEIGHTS OF EXPANDED METAL

If it is decided to use sheets 3' wide (the most convenient), divide the length of the panel by 2.75 to obtain number of sheets lapping 3" on edge. Add to the total length (width of panel  $\times$  number of panels) 1' for end bearings. Divide total length by 11.25 to get number of sheets 12' long; or by 7.25 to get number of sheets 8' long. This gives 9" end lap.

If the tables do not contain the required area proceed as follows: Determine area by the proper formulas. Multiply this area in sq. ins. per 12"

| Width of Sheets—Feet | 3 INCH MESH                       |              |                | 2 1/4 INCH MESH                   |              |                | 3 INCH MESH                       |              |                | Width of Sheets—Feet |
|----------------------|-----------------------------------|--------------|----------------|-----------------------------------|--------------|----------------|-----------------------------------|--------------|----------------|----------------------|
|                      | Area per 12" width 0.059 sq. ins. |              |                | Area per 12" width 0.087 sq. ins. |              |                | Area per 12" width 0.109 sq. ins. |              |                |                      |
|                      | Wt. per sq. ft. 0.2 lbs.          |              |                | Wt. per sq. ft. 0.370 lbs.        |              |                | Wt. per sq. ft. 0.370 lbs.        |              |                |                      |
|                      | Area Sq. Ins. 12" Wide            |              |                | Area Sq. Ins. 12" Wide            |              |                | Area Sq. Ins. 12" Wide            |              |                |                      |
|                      | One Mesh Lap                      | Two Mesh Lap | Three Mesh Lap | One Mesh Lap                      | Two Mesh Lap | Three Mesh Lap | One Mesh Lap                      | Two Mesh Lap | Three Mesh Lap |                      |
| 2                    | .066                              | .074         | .081           | .095                              | .103         | .111           | .123                              | .136         | .150           | 2                    |
| 3                    | .064                              | .069         | .074           | .093                              | .098         | .103           | .118                              | .127         | .136           | 3                    |
| 4                    | .063                              | .066         | .070           | .091                              | .096         | .099           | .116                              | .123         | .129           | 4                    |
| 5                    | —                                 | —            | —              | —                                 | —            | —              | —                                 | —            | —              | 5                    |
| 6                    | .061                              | .064         | .066           | .090                              | .092         | .094           | .113                              | .118         | .123           | 6                    |
| 7                    | .061                              | .063         | .065           | .089                              | .092         | .094           | .113                              | .117         | .121           | 7                    |
| 8                    | .061                              | .063         | .065           | .089                              | .091         | .093           | .112                              | .116         | .119           | 8                    |
| 9                    | .061                              | .062         | .064           | .089                              | .091         | .092           | .112                              | .115         | .118           | 9                    |
| 10                   | —                                 | —            | —              | —                                 | —            | —              | —                                 | —            | —              | 10                   |
| 12                   | .060                              | .061         | .063           | .088                              | .089         | .091           | .111                              | .113         | .116           | 12                   |
|                      | 2 1/4 INCH MESH                   |              |                | 3 INCH MESH                       |              |                | 3 INCH MESH                       |              |                |                      |
|                      | Area per 12" width 0.13 sq. ins.  |              |                | Area per 12" width 0.162 sq. ins. |              |                | Area per 12" width 0.242 sq. ins. |              |                |                      |
|                      | Wt. per sq. ft. 0.44 lbs.         |              |                | Wt. per sq. ft. 0.55 lbs.         |              |                | Wt. per sq. ft. 0.81 lbs.         |              |                |                      |
| 2                    | .142                              | .154         | .166           | .182                              | .203         | .223           | .273                              | .304         | .334           | 2                    |
| 3                    | .138                              | .146         | .154           | .176                              | .189         | .203           | .263                              | .283         | .304           | 3                    |
| 4                    | .136                              | .142         | .148           | .172                              | .182         | .193           | .258                              | .273         | .289           | 4                    |
| 5                    | —                                 | —            | —              | .170                              | .178         | .186           | .255                              | .267         | .279           | 5                    |
| 6                    | .134                              | .138         | .142           | .169                              | .175         | .182           | .253                              | .263         | .273           | 6                    |
| 7                    | .134                              | .137         | .141           | .168                              | .174         | .178           | .252                              | .260         | .269           | 7                    |
| 8                    | .133                              | .136         | .139           | .167                              | .172         | .177           | .251                              | .258         | .266           | 8                    |
| 9                    | .133                              | .135         | .138           | .166                              | .171         | .176           | .250                              | .256         | .263           | 9                    |
| 10                   | —                                 | —            | —              | .166                              | .170         | .174           | .249                              | .255         | .261           | 10                   |
| 12                   | .132                              | .134         | .136           | .165                              | .169         | .172           | .248                              | .253         | .258           | 12                   |
|                      | 3 INCH MESH                       |              |                | 3 INCH MESH                       |              |                | TABLE XVIII                       |              |                |                      |
|                      | Area per 12" width 0.324 sq. ins. |              |                | Area per 12" width 0.4 sq. ins.   |              |                |                                   |              |                |                      |
|                      | Wt. per sq. ft. 1.07 lbs.         |              |                | Wt. per sq. ft. 1.36 lbs.         |              |                |                                   |              |                |                      |
| 2                    | .365                              | .405         | .445           | .450                              | .500         | .650           |                                   |              |                | 2                    |
| 3                    | .351                              | .378         | .405           | .433                              | .467         | .500           |                                   |              |                | 3                    |
| 4                    | .344                              | .364         | .385           | .425                              | .450         | .475           |                                   |              |                | 4                    |
| 5                    | .340                              | .356         | .372           | .420                              | .440         | .460           |                                   |              |                | 5                    |
| 6                    | .336                              | .351         | .364           | .417                              | .433         | .450           |                                   |              |                | 6                    |
| 7                    | .335                              | .347         | .359           | .414                              | .427         | .444           |                                   |              |                | 7                    |
|                      |                                   |              |                |                                   |              |                | Showing increase                  |              |                |                      |
|                      |                                   |              |                |                                   |              |                | in average area                   |              |                |                      |
|                      |                                   |              |                |                                   |              |                | per 12" width                     |              |                |                      |
|                      |                                   |              |                |                                   |              |                | by lapping                        |              |                |                      |
|                      |                                   |              |                |                                   |              |                | sheets of                         |              |                |                      |
|                      |                                   |              |                |                                   |              |                | Expanded                          |              |                |                      |
|                      |                                   |              |                |                                   |              |                | Metal                             |              |                |                      |

wide by 36". Divide the product by 39 which will give the area per 12" wide to call for in sheets 3' wide lapping 3" on the edge. The weight per sq. ft. = area sq. ins. per 12" wide  $\times$  3.396.



#### USE OF FACTOR TABLES

The page 16 Roof and Floor Steel booklet is filled with factor tables for converting quantities in one system into equivalent quantities under other loading, span and arrangement.

Northwestern is now able to supply a safe superior product (steel) sold at 25¢ per sq. ft.

Table VII, page 11, same book, a slab  $2\frac{1}{2}$  ins. thick will do. Weight of slab 31 lbs., making total load 81 lbs. per sq. ft.

Partially continuous slab. (p. 18)

$s' \times 1.12 = 6 \times 1.12 = 6.72'$  new span for same slab.  
 $w' \times 1.25 = 81 \times 1.25 = 101$  lbs. sq. ft. new total load  
 $101 - 31 = 70$  the new live load for same slab.

If original load is sufficient and span of 6 feet is all right, then;  $\frac{w}{1.25} = \frac{81}{1.25} = 65$ , new total load for 6 foot span.

The nearest to this is to be found in Table VI, page 10, where the live load is 32 lbs. and the dead load 31 lbs. while the reinforcement is cheaper. The total load is 63 lbs. and the span freely supported.  $63 \times 1.25 = 79$  lbs. partially continuous. The total load is always considered and the ultimate load is four times the total load.

The same calculations can be made for continuous slabs, using 1.22 instead of 1.12 when dealing with spans; and 1.50 instead of 1.25 when dealing with loads.

For square slabs the following example will suffice. A panel 10 ft. sq. is loaded 90 lbs. to the sq. ft. In Table IX, page 13, we find for a freely supported slab the slab will be 5" thick and the reinforcement consists of 3" mesh, 10 ga. single strand with  $\frac{5}{8}$ " sq. bars 18" on centers wired to the sheet. Total load=152 lbs.

In this example we must find a new slab and new reinforcement to carry the same load on a square panel.

$$\frac{w}{2.50} = \frac{152}{2.50} = 61 \text{ lbs. total load per sq. ft.}$$

We must look then in the other tables to find a slab to carry a total load of 61 lbs. per sq. ft. on a span of 10' with a slab less than 5" thick.

The nearest to this is found in Table VIII, page 12, where a slab  $3\frac{1}{2}$ " thick will do, reinforced with 3" mesh, 10 ga. D. S. There will be two layers at right angles and the concrete must be increased half an inch for the extra layer, thus making the slab 4" thick. In this example one inch of concrete is saved, thus reducing weight but no saving in cost is effected. However the slab is reinforced properly, which is the aim of good design.

In the tables the factor of safety is four. The total load is the sum of the weight of slab and superimposed safe load. Multiply total load by 4 for breaking load. Deduct weight of slab to get load that must be placed on slab to break it. One-fourth of this may be assumed as the live load and we will then be designing as some men design.

EXAMPLE. — Roof and Floor Slab booklet, page 11, Table VII, span 10', load 17 lbs. per sq. ft., weight of slab 73 lbs., total load 90 lbs. Breaking load (total)  $90 \times 4 = 360$  superimposed breaking load.  $360 - 90 = 270$  lbs. One-fourth of 270 lbs. = 67.5 lbs., a load greater than usually figured for dwellings and porch floors.

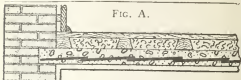


FIG. A.

The three cross-sections, Figures A, B and C, illustrate different methods of supporting reinforced concrete floors on brick walls, and different methods of finishing the floors. In Figures A and B the plastering is applied directly to the underside of floor slabs. In Figure B an underfloor is first nailed to the concrete and to this underfloor the finished floor is nailed.

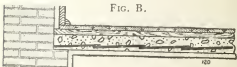


FIG. B.

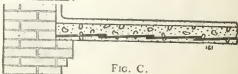


FIG. C.

### STRESSES USED IN CALCULATING THE TABLES.

The tables have been calculated by the formulas given in this booklet, allowing a thickness of concrete of three quarters of an inch below the center of the steel (half an inch covering) when the expanded metal alone is used; and one inch when bars are used in combination with the expanded metal.

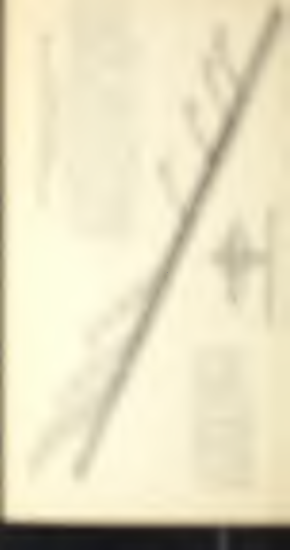
The fiber stress in the concrete was assumed at 700 lbs. and this governed the strength of the slab in the thin slabs at the tops of the tables. The steel stress of course is low in those slabs. As the slabs became thicker however the steel stress increased until it reached 16,000 lbs. per sq. in. after which that value was maintained and the concrete stress grew less, this being met by changing the character of the concrete. The same method was used in the slabs reinforced with the bars and mesh combined but in this case the steel stress was allowed to go to 18,000 pounds per sq. in. as a maximum.

### WEB REINFORCEMENT.

In such a booklet as this the subject of internal stresses in beams and proportioning of web reinforcement can hardly be gone into thoroughly. The reader is referred to standard treatises on reinforced concrete. When the span exceeds ten times the depth of the beam it is seldom that web reinforcement is needed. When the beam however is comparatively deep as compared with the length the question of web reinforcement assumes importance.

Web reinforcement is supplied by stirrups, upright or inclined. Inclined stirrups are most efficient and it is important that they go far enough up to permit of secure anchorage in the concrete in compression in the top of the beam or slab. Many beams fail by diagonal tension in spite of the imbedded stirrups because the stirrups are too short. Many beams fail with stirrup reinforcement because the stirrups are not rigidly attached to the horizontal reinforcement.

THE NORTHWESTERN UNIT BEAM (pat. apl. for) is a beam fabricated in our factory and shipped flat to destination, the stirrups being bent up into position by the workmen. The construc-



tion is simple and readily understood. There are as many strips of expanded metal as there are stirrups on one half the beam. These strips form part of the horizontal reinforcement and are bent up at each end to act as stirrups and are bent horizontally at the top for anchorage. The method of clamping all the sheets together and attaching them to the rods or bars is also patented and this fastening is adjustable so the reinforcement can be held at any desired height above the bottom of the form. The patent covers the use of wire fabric as well as expanded metal. The expanded metal nests perfectly so that no trouble is experienced in pouring the concrete.

### COLUMNS.

The accompanying column diagram is so simple as to require little explanation. The horizontal lines represent the total load in thousands of pounds carried by the column. The diagonal line at the right shows where the steel alone will carry the load. The vertical lines indicate area of steel in square inches. The full curves give sizes of columns of reinforced concrete when the concrete stress is 500 lbs. per sq. in. and the dotted curves give sizes of columns when the concrete stress is 350 lbs. per sq. in. The steel stress is 15 times the concrete stress. The reinforcement is supposed to consist of bars or rods (smooth, not deformed) placed vertically in the forms at least two inches away from the face of the column, and tied together at intervals equal to the side of the column, by No. 8 wire. The dimensions of the columns here given are the dimensions necessary for strength and the two inches all round required for fire protection must be added to these dimensions.

Some concrete is necessary to protect the steel and it cannot be relied on for compressive strength for a fire will injure it. However the size of the column may be kept down by designing it for a 350 lb. compressive stress and setting the steel in  $1\frac{1}{2}$ " from the faces. A fire will then injure only the outside skin which will result in the concrete thereafter carrying a higher stress within the steel while the outer concrete may be plastered over to hide the effects of the fire.



This diagram can be used for hooped columns by first ascertaining the amount of vertical steel required. The same amount of steel in the form of expanded metal wrapped as hooping can be figured on as carrying a stress  $2\frac{1}{2}$  times that allowed in the vertical steel. The Northwestern Expanded Metal Co. fabricates in the factory column reinforcement composed of vertical rods wired to sheets of light expanded metal, which ties them together instead of the wire mentioned. These columns are shipped out flat and set in place by the workmen, the mesh being bent on the job. This company will also send the columns out already bent into box shape if desired but of course the freight will be higher. Hooped, or wound columns, in which the hooping is heavy expanded metal are also fabricated to order at the factory and shipped out ready to set up.

### COST OF WORK.

In response to many inquiries as to cost of work we offer the following tables taken from a paper read by Mr. Leonard C. Wason, President of the Aberthaw Construction Company, Boston, Mass., at the Fifth Annual Convention of the National Association of Cement Users, January 1909. The reader should obtain a copy of the full paper in order to analyse these costs properly. In looking at the item of steel it is well to know that expanded metal is the lowest in cost of erection of any form of reinforcement steel. The steel costs

| Location.                           | STEEL.        |            | Cost of Handling. | Cost per Ton. |
|-------------------------------------|---------------|------------|-------------------|---------------|
|                                     | Weight, Tons. |            |                   |               |
| Office building, Portland, Me. .... | 224½          | \$5,115 32 | \$15 76           |               |
| Fire station, Weston, Mass. ....    | 8½            | 40 25      | 4.74              |               |
| Mill, Chelsea, Mass. ....           | 65½           | 518 81     | 8.41              |               |
| Coal bins, Dalton, Mass. ....       | 8½            | 41.75      | 7.25              |               |
| Dam, Auburn, Me. ....               | 55            | 505 75     | 9.18              |               |
| Filter, Warren, R. I. ....          | 19            | 142 59     | 5.40              |               |
| Tank, Lincoln, Me. ....             | 8½            | 69 38      | 8.16              |               |
| Tar well, Springfield. ....         | 15½           | 55 21      | 3.52              |               |
| Monument, Provincetown. ....        | 21½           | 136 84     | 6.18              |               |
| Mill, Greenfield. ....              | 90½           | 1,232 01   | 10.20             |               |
| Machine shop, Milton, Mass. ....    | 50½           | 177 16     | 8.75              |               |
| Coal pocket, Lawrence, Mass. ....   | 28            | 441 18     | 15.47             |               |
| Mill, Southbridge. ....             | 53½           | 142 76     | 2.67              |               |
| Mill, S. Windham, Me. ....          | 250           | 3,075 60   | 10.51             |               |
| Mill, Attleboro, Mass. ....         | 45½           | 255 02     | 5.75              |               |
| Garage, Newton, Mass. ....          | 20            | 95 58      | 4.32              |               |
| Mill Southbridge, Mass. ....        | 20            | 100 68     | 3.34              |               |
| Coal pocket, Hartford, Conn. ....   | 195           | 2,316 40   | 11.85             |               |
| Filter, Lawrence, Mass. ....        | 41½           | 112 14     | 2.54              |               |
| Warehouse, Portland, Me. ....       | 62            | 462 59     | 7.47              |               |
| Standpipe, Attleboro, Mass. ....    | 130½          | 1,547.60   | 7.75              |               |
| Highest. ....                       | ...           | .....      | 14.47             |               |
| Lowest. ....                        | ...           | .....      | 2.54              |               |
| Average of 21. ....                 | ...           | .....      | 8.52              |               |

given here which are a list of prices in place and as to how the prices have gone. On an average the cost of a number of other buildings from other contractors, has been taken as follows, the costs being expressed in percentages. Labor 45%, cement 14%, stone and sand 10%, steel 20%, lumber 11%, and a running 5%.

The reader must remember that the costs were obtained by a very large corporation engaged exclusively in reinforced concrete work and employing as superintendents and foremen experienced, skilled men. The average contractor handling occasional jobs cannot hope to reach these figures except under very favorable circumstances.

COST OF BUILDING WALLS ABOVE GRADE

| Type of Wall                     | Cost per square foot |       |          | Cost per cubic foot |        |               |       |       |
|----------------------------------|----------------------|-------|----------|---------------------|--------|---------------|-------|-------|
|                                  | Concrete             | Labor | Material | Concrete            | Amort. | Team and mule | Plant | Total |
| 1. Plain Wall                    | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 2. Wall with 1" reinforcement    | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 3. Wall with 2" reinforcement    | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 4. Wall with 3" reinforcement    | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 5. Wall with 4" reinforcement    | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 6. Wall with 5" reinforcement    | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 7. Wall with 6" reinforcement    | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 8. Wall with 7" reinforcement    | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 9. Wall with 8" reinforcement    | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 10. Wall with 9" reinforcement   | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 11. Wall with 10" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 12. Wall with 11" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 13. Wall with 12" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 14. Wall with 13" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 15. Wall with 14" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 16. Wall with 15" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 17. Wall with 16" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 18. Wall with 17" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 19. Wall with 18" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 20. Wall with 19" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 21. Wall with 20" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 22. Wall with 21" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 23. Wall with 22" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 24. Wall with 23" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 25. Wall with 24" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 26. Wall with 25" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 27. Wall with 26" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 28. Wall with 27" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 29. Wall with 28" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 30. Wall with 29" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 31. Wall with 30" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 32. Wall with 31" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 33. Wall with 32" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 34. Wall with 33" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 35. Wall with 34" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 36. Wall with 35" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 37. Wall with 36" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 38. Wall with 37" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 39. Wall with 38" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 40. Wall with 39" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 41. Wall with 40" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 42. Wall with 41" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 43. Wall with 42" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 44. Wall with 43" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 45. Wall with 44" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 46. Wall with 45" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 47. Wall with 46" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 48. Wall with 47" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 49. Wall with 48" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 50. Wall with 49" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 51. Wall with 50" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 52. Wall with 51" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 53. Wall with 52" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 54. Wall with 53" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 55. Wall with 54" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 56. Wall with 55" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 57. Wall with 56" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 58. Wall with 57" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 59. Wall with 58" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 60. Wall with 59" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 61. Wall with 60" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 62. Wall with 61" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 63. Wall with 62" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 64. Wall with 63" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 65. Wall with 64" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 66. Wall with 65" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 67. Wall with 66" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 68. Wall with 67" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 69. Wall with 68" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 70. Wall with 69" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 71. Wall with 70" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 72. Wall with 71" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 73. Wall with 72" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 74. Wall with 73" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 75. Wall with 74" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 76. Wall with 75" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 77. Wall with 76" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 78. Wall with 77" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 79. Wall with 78" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 80. Wall with 79" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 81. Wall with 80" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 82. Wall with 81" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 83. Wall with 82" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 84. Wall with 83" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 85. Wall with 84" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 86. Wall with 85" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 87. Wall with 86" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 88. Wall with 87" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 89. Wall with 88" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 90. Wall with 89" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 91. Wall with 90" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 92. Wall with 91" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 93. Wall with 92" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 94. Wall with 93" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 95. Wall with 94" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 96. Wall with 95" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 97. Wall with 96" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 98. Wall with 97" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 99. Wall with 98" reinforcement  | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| 100. Wall with 99" reinforcement | 1.00                 | 1.00  | 1.00     | 1.00                | 1.00   | 1.00          | 1.00  | 1.00  |
| Average of 10                    |                      |       |          |                     |        |               |       |       |

## COST OF FOOTING AND MASS FOUNDATIONS.

Forms per square foot.

Concrete per cubic foot.

| Location.                       | Carpenter labor. | Lumber. | Nails and wire. | Total. | Concrete labor. | Gen. labor. | Cement. | Aggregate. | Feet and miles. | Plant. | Total. |
|---------------------------------|------------------|---------|-----------------|--------|-----------------|-------------|---------|------------|-----------------|--------|--------|
| Lower house, Greenfield.        | .174             | .677    | .002            | .853   | .445            | .034        | .073    | .003       | .006            | .016   | .269   |
| Long foundation, Taunton, Mass. | .354             | .675    | .001            | .030   | .945            | .001        | .005    | .004       | .004            | .017   | .161   |
| Good gate, Sharon, Me.          | .071             | .813    | .003            | .117   | .033            | .001        | .074    | .001       | .003            | .014   | .139   |
| Amal, Lowell, Mass.             | .031             | .025    | .001            | .085   | .015            | .001        | .086    | .001       | .004            | .042   | .243   |
| Condalia, Providence            | .042             | .043    | .003            | .114   | .033            | .004        | .073    | .004       | .011            | .049   | .275   |
| Am. Merrimack, N. H.            | .044             | .017    | .001            | .108   | .081            | .003        | .090    | .003       | .008            | .081   | .218   |
| Foundation, Boston, Mass.       | .011             | .001    | .001            | .018   | .015            | .001        | .081    | .003       | .006            | .016   | .109   |
| Foundation, Boston, Mass.       | .005             | .003    | .003            | .137   | .037            | .013        | .041    | .004       | .019            | .015   | .233   |
| Foundation, Boston, Mass.       | .034             | .031    | .003            | .067   | .043            | .003        | .041    | .003       | .005            | .010   | .149   |
| Gas holder, Springfield.        | .018             | .011    | .004            | .029   | .051            | .003        | .047    | .016       | .010            | .009   | .186   |
| Foundation, Providence, R. I.   | .113             | .017    | .001            | .131   | .081            | .029        | .083    | .049       | .013            | .049   | .376   |
| Richard                         | .019             | .001    | .001            | .018   | .035            | .003        | .047    | .003       | .004            | .010   | .101   |
| Lowest                          | .019             | .004    | .003            | .043   | .046            | .007        | .071    | .007       | .007            | .021   | .239   |
| Average of 10.                  | .057             | .034    | .003            | .093   | .046            | .007        | .071    | .007       | .007            | .021   | .239   |

## COST OF FOUNDATION WALLS.

Concrete per cubic foot.

| Location.                        | Carpenter labor. | Lumber. | Nails and wire. | Total. | Concrete labor. | Gen. labor. | Cement. | Aggregate. | Feet and miles. | Plant. | Total. |
|----------------------------------|------------------|---------|-----------------|--------|-----------------|-------------|---------|------------|-----------------|--------|--------|
| Filter, Warren, R. I.            | .103             | .048    | .004            | .155   | .032            | .037        | .098    | .484       | .012            | .031   | .264   |
| Tar well, Springfield.           | .021             | .031    | .002            | .104   | .040            | .013        | .004    | .016       | .013            | .040   | .177   |
| Tunnel, New Bedford.             | .048             | .045    | .001            | .094   | .013            | .013        | .303    | .003       | .007            | .018   | .337   |
| Filter, Exeter, N. H.            | .124             | .007    | .003            | .134   | .054            | .004        | .071    | .116       | .004            | .010   | .305   |
| Filter, Lawrence, Mass.          | .052             | .042    | .001            | .101   | .048            | .017        | .083    | .004       | .013            | .032   | .244   |
| Theatre, Portland, Me.           | .081             | .024    | .001            | .106   | .112            | .013        | .073    | .076       | .003            | .016   | .303   |
| Warehouse, Portland, Me.         | .063             | .005    | .001            | .069   | .140            | .019        | .046    | .016       | .004            | .017   | .233   |
| Warehouse, N. Andover            | .047             | .014    | .001            | .062   | .108            | .004        | .001    | .045       | .015            | .010   | .264   |
| Filter, Lawrence, Mass.          | .048             | .025    | .003            | .076   | .055            | .008        | .034    | .021       | .011            | .010   | .234   |
| Residence, N. Andover.           | .065             | .009    | .001            | .075   | .037            | .012        | .072    | .045       | .013            | .010   | .236   |
| Retaining wall, Nantucket, Conn. | .134             | .017    | .001            | .152   | .052            | .013        | .014    | .033       | .013            | .010   | .319   |
| Hospital, Waltham, Mass.         | .048             | .028    | .001            | .077   | .043            | .014        | .016    | .043       | .013            | .010   | .292   |
| Greenhouse, Brookline, Mass.     | .033             | .035    | .001            | .069   | .051            | .007        | .016    | .004       | .010            | .010   | .189   |
| Hotel, Brookline, Mass.          | .037             | .018    | .001            | .056   | .043            | .003        | .080    | .004       | .001            | .040   | .244   |
| Highest                          | .134             | .044    | .004            | .182   | .113            | .007        | .309    | .116       | .001            | .010   | .318   |
| Lowest                           | .032             | .004    | .001            | .039   | .037            | .007        | .028    | .007       | .008            | .010   | .108   |
| Average                          | .048             | .033    | .003            | .103   | .046            | .007        | .063    | .043       | .007            | .017   | .283   |



| Location                       | COST OF CONCRETE COLUMNS. |                |                 |             | Concrete per cubic foot. |             |                 |        | Total. |
|--------------------------------|---------------------------|----------------|-----------------|-------------|--------------------------|-------------|-----------------|--------|--------|
|                                | Forms per square foot     | Nails and wire | Concrete labor. | Gen. labor. | Cement                   | Aggr. sale. | Aggr. and misc. | Plant. |        |
| Office building, Portland, Me. | .122                      | .079           | .001            | .173        | .087                     | .034        | .013            | .023   | .573   |
| Coal pocket, Lawrence, Mass.   | .057                      | .024           | .001            | .002        | .013                     | .041        | .008            | .016   | .207   |
| Mill, Southbridge, Mass.       | .097                      | .002           | .002            | .004        | .107                     | .016        | .027            | .030   | .211   |
| Mill, Attleboro, Mass.         | .023                      | .022           | .001            | .114        | .002                     | .034        | .013            | .034   | .169   |
| Mill, Southbridge, Mass.       | .004                      | .054           | .001            | .137        | .103                     | .007        | .017            | .013   | .304   |
| Mill, Southbridge, Mass.       | .018                      | .017           | .002            | .002        | .009                     | .013        | .041            | .009   | .205   |
| Coal pocket, Hartford, Conn.   | .071                      | .003           | .003            | .134        | .070                     | .028        | .019            | .025   | .335   |
| Garage, Brookline, Mass.       | .118                      | .014           | .001            | .137        | .087                     | .017        | .013            | .016   | .282   |
| Warehouse, Portland, Me.       | .061                      | .012           | .001            | .095        | .103                     | .027        | .041            | .034   | .340   |
| Gravel mill, Lawrence, Mass.   | .113                      | .042           | .002            | .181        | .106                     | .004        | .008            | .013   | .371   |
| Light                          | .002                      | .012           | .001            | .004        | .002                     | .027        | .008            | .013   | .101   |
| Lowest                         | .002                      | .006           | .001            | .002        | .005                     | .049        | .001            | .023   | .081   |
| Average of 5                   | .082                      | .036           | .001            | .134        | .085                     | .049        | .013            | .023   | .281   |

| Location                       | COST OF CONCRETE SLABS BETWEEN STEEL BEAMS. |                |                 |             | Concrete per cubic foot. |             |                 |        | Total. |
|--------------------------------|---|----------------|-----------------|-------------|--------------------------|-------------|-----------------|--------|--------|
|                                | Forms per square foot                       | Nails and wire | Concrete labor. | Gen. labor. | Cement                   | Aggr. sale. | Aggr. and misc. | Plant. |        |
| Beachery, E. Hampton           | .054  | .027           | .002            | .002        | .137                     | .073        | .302            | .048   | .561   |
| Machine shop, Milton, Mass.    | .017  | .007           | .000            | .013        | .114                     | .023        | .016            | .034   | .182   |
| Foundry, N. Britain, Conn.     | .014  | .046           | .002            | .021        | .006                     | .016        | .044            | .022   | .194   |
| Stables, Boston, Mass.         | .004  | .011           | .001            | .019        | .129                     | .076        | .010            | .016   | .354   |
| Residence, Milton, Mass.       | .110  | .021           | .002            | .004        | .137                     | .009        | .003            | .010   | .428   |
| Power House, Pittsfield, Mass. | .025  | .009           | .001            | .131        | .125                     | .048        | .013            | .010   | .353   |
| Laundry, Boston, Mass.         | .028  | .004           | .002            | .001        | .094                     | .009        | .022            | .010   | .312   |
| Prison, Portsmouth, N. H.      | .048  | .017           | .005            | .002        | .208                     | .075        | .009            | .009   | .517   |
| Paper mill, Milford, Mass.     | .007  | .003           | .002            | .002        | .143                     | .062        | .027            | .010   | .418   |
| Power house, Quincy, Mass.     | .023  | .018           | .002            | .013        | .132                     | .028        | .019            | .016   | .372   |
| School, Waltham, Mass.         | .018  | .026           | .004            | .004        | .128                     | .029        | .024            | .010   | .428   |
| Foundry, Providence, R. I.     | .043  | .021           | .001            | .014        | .128                     | .009        | .004            | .010   | .373   |
| Foundry, Providence, R. I.     | .028  | .012           | .003            | .013        | .075                     | .024        | .004            | .013   | .255   |
| Lowest                         | .002  | .002           | .001            | .002        | .123                     | .068        | .001            | .013   | .255   |
| Average of 5                   | .041  | .022           | .002            | .013        | .123                     | .068        | .001            | .013   | .255   |



- No. 6. **SIDEWALKS.**—Contains details of sidewalk construction in accordance with Building Ordinance requirements in many cities, together with tables of quantities of material so that the labor of the designer is reduced to a minimum. Ready May 15th, 1909.
- No. 7. **SEWERS AND CULVERTS.**—Contains detail drawings for circular, egg-shaped and square sewers and culverts with tables of quantities and valuable formulas and data. Ready June 1st, 1909.
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